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ABSTRACT

This document describes some experiences in a science/technology/society (STS) program for an eighth grade science course at a small rural school in Iowa. The background information about the school and the general goal of the STS program are outlined. The curriculum structure of the program related to water as a reusable resource is presented. Many activities are provided; including the measurement of the amount of water used by individuals, water testing, and lobbying the legislators. Some instructional strategies related to the program are suggested, including how to motivate students and how to structure teaching activities so as to achieve desired learning outcomes. Evaluation methods for teaching and testing concepts, and use of community resources are described. (YP)

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or

"Let's Get Relevant."

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Glidden-Ralston Community Schools
Glidden, Iowa 51443

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WATER QUALITY-8TH GRADE EARTH SCIENCE

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I. Introduction. Glidden-Ralston Community School is a rural, midwestern, consolidated school district. The city of Glidden has a population of approximately 1,200 people. Ralston is a town of approximately 150 people. The student population is drawn from these two towns as well as from the farm area surrounding the two communities. Located seven miles from Carroll, Iowa, a good number of parents work in Carroll and maintain residences in Glidden.

Enrollment in the school systems is 440 students (K-12). Class size for the Glidden-Ralston schools averages 30-35 students. The student population has remained constant for the past five years. The structure of the Glidden-Ralston school system can be summarized as follows: grades 1-3 are self-contained classrooms; grades 4-6 are departmentalized; grades 7-12 are traditional scope and sequences with modular scheduling. Classes are sectioned with approximately fifteen students in each.

II. The NSTA SESE Program. The Science/Technology/Society (STS) program at Glidden-Ralston is presently in a variety of states. There are two teachers responsible for science education in grades 7-12. Basically, one staff member has responsibility in life sciences, while the other staff member is responsible for the physical sciences.

The elementary teachers, grades K-6, are basically at an awareness level with anticipation of implementation. In grades 7-12 for the life sciences, the instructor has been developing/implementing STS activities for the past two years. STS in the physical sciences, grades 7-12, has been adapted and implemented since teacher participation in the initial STS Chautauqua was completed during the 1985-86 school year. Both teachers actively involved with STS began with an experimental/experiential approach and have developed activities and classroom materials as the need was seen due to interaction with students and upon further exposure to the work of others in the STS program.

The strength of the program is based on three interactions: teacher-student, inter-school staff, and intra-school staff/participation. The teacher and students work together to set the tone/direction of science education. Questions students ask and interests students show develop the format for classroom activities and structure. The energy/excitement of the staff members working with each other to develop and implement more exciting and meaningful science, results in cooperation and cohesion within the department. Attendance and interaction with other teachers at Chautauquas provide continuing support, reinforcement, and new challenges for each participant. The program itself is an

individual teacher's own making, but is reinforced through constant and continuing communication at all levels.

Program Goals. The general goal of the STS program is to approach science education from a student interest and applications/connections base. Emphasis has been placed on studying science from this aspect. Developing positive attitudes and creativity skills have been worked on with much more attention as a result of this base. Process and knowledge components of science education tend to fall into place with this approach.

Students taking core and elective science courses are encouraged to learn about and question issue-based concepts from local and global perspectives. Opportunities to discuss issues of personal and societal concern about the environment generally result in student awareness of the effects of personal and societal decisions. Establishing values and perspectives from a non-biased viewpoint are desired goals for students. Realization of the connections between society, technology, and science, and the citizen's role in making decisions to take action is also a desired outcome of the overall science program at Glidden-Ralston.

Departmental goals of the science program at Glidden-Ralston include (not prioritized):

*development of values and decision-making skills
*development of critical-thinking skills
*development of a knowledge base
*understanding of the processes of science
*development of reading and writing skills (communication/study skills)
*development of creativity
*understanding of technology and applications
*development of positive attitudes
*development of individual/group responsibility
*development of organizational skills
*realize the interdependence of learning skills
*encourage natural curiosity
*develop problem solving skills
*understand the impact of science
*understand the world around you
*prepare for the future in a changing world.

In addition to the "teaching of science" at Glidden-Ralston, teachers are involved with reading and writing across the curriculum, compliance with the State of Iowa Curriculum, local curriculum goals, and upgrading and maintaining Basic Skills.

Curriculum Structure. "Lets Get Relevant" or Water as a Reusable Resource (This evolved over a three year period beginning with the school year of 1987).

When a person thinks about water and its everyday usage, it may be difficult for some people to think of water as a reusable resource. When a person washes something, the water comes out of the faucet; after the water is used, it goes down the drain. This seems like a one-way trip.

Another idea that is hard to grasp is that there is just as much water on the earth today as there ever was, but yet the public is constantly reminded of water shortages, water quality, and threats to the environment because of water pollution.

What is the water cycle? The water cycle is a process described in the textbook by a nice flow chart in which the water of the earth undergoes a series of changes due to evaporation, condensation, and runoff happenings. The concept itself is fairly easy for a junior high student to grasp when broken down in a "conventional teaching" situation.

To introduce this unit, the students respond to the initial question "Where does the water that your family uses come from?" Their answers prove interesting:

...from the ground.
...from that big tower over there!
...from the faucet.

A student asked, "How is our water in town different from country water?" Responses indicated very little understanding of the differences other than country water tastes different. The following argument as to which tastes better and which was better for them, led to some interesting side-trips. One other question asked had to do with the water seepage problem that most homeowners with basements experience during moderate to heavy rainfall in Glidden. Most of the student "get to help" clean this up and wondered why it happens and why it happens more often to the people on the west side of town.

At the time of the initial study in 1986, Glidden was considering several alternatives to improve its water treatment, which had become outdated for current use. The hot item in the town news was city council action on the EPA mandate to update the system.

With this as a beginning, the class decided to take a closer look at the "water cycle" as it related to the situation in Glidden, Iowa. This was an opportunity to:

1. study the concept of water cycling (recycling);
2. study water treatment methods;
3. study water usage in the home and community; .
4. study value of water treatment in the home;
5. study the treatment of water once it leaves the home;
6. consider issues of local/state importance;
7. make use of resources in the community; and
8. look at the legislative process for groundwater.

A short, traditional introduction to environmental science and the water cycle included building a terrarium and observing changes that took place over a period of time--a traditional, meaningful introductory activity that introduces many environmental concepts. The class then went out into the "real world" to

find out what was happening to the water that is needed and used every day in Glidden, Iowa.

Incorporated into this unit was a series of activities from the outlook program dealing with groundwater formation, quality, and concerns. The activities based on the learning cycle approach to science education greatly enhanced the entire study of "the water cycle." When appropriate for student-based questions/concept development, water-soil interactions and groundwater formation activities were included in the series of activities. The activities provided a great experience and reinforcement for the entire sequence. Joe Halbur, a naturalist with the Carroll County Conservation Commission, visited the earth science class to provide some expertise on soil and soil problems in Carroll County.

A particularly significant activity that can be incorporated into the water quality sequence at a variety of different places involves student cleanup of "foul water" (ChemCom, 1986, ACS). The students are given the task of cleaning up a sample of water containing coffee grounds, garlic, salad oil, and water (let it set for two to three days and it will leave an even more lasting impression) so that it could be used for washing hands. The task is left open-ended with the students developing plan(s) to clean up the water and actually carrying out a step-by-step plan to produce a better quality water.

One day while staring out the window, the city water tower came clearly into view. This was yet another vehicle with which to provide an understanding of water. In posing the question as to what happens to the water that is used in Glidden, it became apparent that the students had never been to the water treatment facility. The water treatment facility is a fairly small building that is pretty much taken for granted by all. Something went on in that building that eventually resulted in water coming to the school and homes in town--but what the process involved was not understood.

Arrangements were made to visit the water treatment facility by contacting the city clerk. A visit to our water treatment and pumping facility was set and the city clerk arranged for one of the city employees to lead the first tour. The students were not very excited about this initially and figured that the little building with the water tower lingering over it was not a great place to take a field trip. However, the idea of getting out of the classroom sounded good!

Once inside the water treatment facility and with the explanation provided by the city employee, questions started popping up. Taking the video camera and recorder along and taping the visit proved beneficial. The trip, which lasted about 30 minutes, allowed time to return to the classroom and have a short discussion. (Only alloted class time was used for the trip, so there was not make-up work or interferences with other classes.) During the next few class meetings interesting discussion followed on a variety of topics including aquifers, filtration, ionization, water testing/requirements, chemical treatment, water storage, and gravity flow from the treatment plant. The video was very useful as it was watched and rewatched several times to clear up questions the students and instructor had about what went on in the little building on the west side of town!

As a result of repeating this trip for the past two years, the city now just makes sure the building is open and the tour is conducted by the instructor--this was a good learning experience for all.

As a culminating activity to this phase, the student wrote a descriptive, sequential story of the water treatment facility. This was done in cooperation with eighth grade English class so that skills being worked on in this class could be applied and related to science class. The cooperative writing effort worked well as an evaluation tool for the trip.

In the textbook a statement is made concerning water usage. The statement reads: "On the average, each person in the United States uses about 265 liters (70 gallons) of water a day at home." After some thought, the general reaction by the students was "NO WAY!" In attacking the validity of the statement--by actually attempting to find out how much water was being used in the home per person during a day-the meter was checked and the reading recorded in the morning before anyone used any water. At night when everyone was finished using water, the meter was read and recorded. This information was collected for one day only; and, even though this was not a totally reliable study, the students were amazed at how much water was actually used in the home on a daily basis, let alone the amount of water used by individuals during the day while in school. In the past two years this study has been expanded to include individual uses of water in the home. Measurement of water used for a toilet flush, shower, washing machine, and other everyday uses were considered. This has allowed the incorporation of measurement, data gathering, and graphing skills into the activity. Additionally, the calculation of how much water costs is completed by using the city utility bill and a few math skills.

During the work on the cost and use of water, a couple of questions came up: How much water does the city of Glidden use and who uses the most? Using a short brainstorming session, the class tried to identify the major users of water in Glidden. The class decided that the egg plant probably was the biggest water user in Glidden. Arrangements were made to visit the egg plant to see how water was used as well as how much. During our visit, which was accomplished during one class period, our questions were not only answered concerning water use but the process of handling 485,000 eggs a day and the technology behind the scenes proved very interesting. How many chickens did it take to lay all of those eggs? How much water did the chickens use--it became a little bit complicated and the amounts of water were "large"--something like 5,000 gallons per chicken, when the tracing of the chicken's life was considered. Incidentally, the question surfaced of "Which came first,. the chicken or the egg?"

Next, consideration of water treatment in the home was approached. An invitation to a representative of Lindsay Water Company was extended to come to the classroom to speak about additional water treatment processes. Prior to the demonstration, the students, especially those from the country, were asked to bring in water samples for testing. There was a very good response to this as almost three-fourths of the rural students brought in samples.

Each sample of water was tested and examined for hardness, presence of various contaminants found in water, and total dissolved solids (TDS). Students

were shown methods/technology for testing and "cleaning up" the water that comes into the home. This presentation was also taped and referred to several times as the class considered the consequences of water treatment in the home. Several students indicated an interest in pursuing questions about water quality for a science fair project. The Lindsay representative volunteered the use of one of the water testing kits for this purpose.

One student, in the third year of a water quality project, has become involved with legislation concerning labels on baby food containers. Originally 50 wells in Carroll County were tested for nitrates. One of the wells, located on a farm with an expectant mother, was found to have over 65 PPM nitrates in the groundwater. A water sample was sent to the state lab and verified. The student alerted the mother and the mother in turn informed the doctor about the situation. The birth went fine. Now the student is involved with a U.S. senator to attempt to get a warning on infant formula containers and the relationship of boiling water and increased nitrate concentration as a result of over-boiling.

Following this presentation, the class considered some of the consequences and implications of water treatment, both by the city and by water conditioning devices. This was accomplished by using a Delphi study (a method of identifying consequences and considering their effects) and incorporated group dynamics skills. Issues such as "What are the effects of putting fluoride or chlorine in water?" and "What are the consequences of installing a water conditioner in the home to remove contaminants?" were a few of the questions considered. Students, working in groups, brainstormed consequences and then determined the probability of each consequence and the overall effect of each consequence. Large group discussion then took place and each group presented their consequences and reasoning for the overall effect.

Shortly after this, one of the students brought in an articles from the newspaper, titled "A Growing Threat to Groundwater is Seen." It must be time to look at the quality of water! Arrangements were made to find out the overall status of the groundwater in Glidden as far as what contaminants it contained. Arrangements were made for the Carroll County Sanitarian to visit our class and share information on the current situation with groundwater and health aspects concerning groundwater in Carroll County. The sanitarian also informed students about well drilling and requirements recently mandated by the state regarding the drilling of wells--Well! Next, one of the students asked why don't we get a well driller to tell us a little more about the well drilling process. The sanitarian gave me the name of a well driller in Dayton, Iowa. With a phone call, the class had another speaker scheduled.

Prior to the driller coming to class, the class constructed and investigated how a well works and the needs to get the groundwater our of an aquifer. The driller was fantastic--this was an STS person!; having no college experience, the knowledge that was needed and learned as a requirement to doing the job efficiently and legally was incredible. A tremendous amount of knowledge was presented to the class. Charts, maps, and a vast storehouse of knowledge was presented along with the process of well drilling. After this visit, approximately two weeks were spent trying to interpret and understand the geology and underground structure in Iowa. Sometimes things just have to "flow"! Originally, there was no plan for going into great depth about topographical

maps, contour maps, glacial history, and geologic history of the state Iowa, but that's where we ended up because of "the questions kids ask."

Next under consideration came legislation to protect the quality of groundwater in Iowa. Acting as lawmakers, the students were to develop a set of rules concerning groundwater protection and conservation. Students first of all identified practices which need to be regulated in order to maintain the quantity and protect the quality of groundwater. Students used information collected in previous activities, as recorded in their journals, to identify those practices which critically harm groundwater. Focus is on both urban and rural practices.

Students then used the list of practices and examples identified to develop a minimum of five rules or laws to help protect the quality and quantity of groundwater. After the rules are agreed on, discussion was held to select 5-10 rules which are most critical. Students, in groups, then were assigned to communicate with state legislators regarding the existence, future existence, and/or non-existence of these laws.

As a results of the letters that were sent, interesting and quick responses were received. One representative volunteered to come to the class to discuss the issues that had been raised and to answer questions the students had about current groundwater legislation. Information regarding the Iowa groundwater bill, which had recently been passed, was interesting when comparing the concerns posed by the students and the language of the legislation.

What happens to the water once it leaves the home? Most people treat this as "out of sight-out of mind."

Arrangements were made with the city once again to tour the waste treatment plant. This probably won't make the Guinness Book of Records, but the earth science class is the only group that has ever toured this facility! The tour was very invigorating! A fine down-to-earth explanation of what happens to water and the other ingredients once it leaves the home was provided. The used water came in as raw sewage and left the plant as cleaned up reusable water. In addition, information as to why Glidden needs to update the waste treatment facility to meet EPA guidelines was discussed. This trip was taped and students used it to complete a writing assignment on sequencing the waste treatment process.

In studying the "water cycle" in this way, there seemed to be much more interest. Learning was accomplished through consideration of local, relevant issues. The instructor and the students became more involved in the learning process and learned as there was a need to know. The most amazing thing is that all of the resources utilized during this study had been available for so many years. It was just a matter of tapping the right ones to create an interest in an earth science unit that was so traditional before. The entire unit took about three months, has now evolved to four months--and is still evolving! Students take a much greater interest in science when it is brought a little closer to home. Statements such as "This is boring" seem to vanish and are replaced by "What are we going to do next?"

The textbook is no longer used in a traditional sense. The text is used as a source for information that is needed to reinforce or for more research. The use of local resources/experts in a particular field has provided a tremendous information base as well. Newspapers, magazine articles, and other media devices have become an important part of our information base, too.

The module on water as a reusable resource began as a 4-5 week unit. Since the initial experience with this module, the concept of water, and the tremendous number of connections to water are leading to a year-long course based on the original concept. Connections are being realized that lead directly into units on other resources, weather, and even space science. A ninth grade (physical science) connection develops very nicely with the study of "Bubbology" as one major strand. In general it might be said that water is now the organizer for the middle school science program.

Instructional Strategies. Thinking about STS or maybe STTS (Science, Technology, in a Thinking Society), the teacher needs to be aware of and to create conditions that are conducive to children's thinking:

*pose problems, raise questions, resolve paradoxes, dilemmas, and discrepancies
*organize the classroom for interaction in a variety of ways
*structure the school and environment for thinking-valuing it, making time for it, obtaining materials for it, and evaluating progress on it
*respond to and share feelings with students--remain positive, create trust, encourage creativity, and listen to what students are saying.

How is this accomplished? There is no one way. But one thing that is pretty certain is that the teacher must think about thinking before diving in. Each teacher will find different ways that will work for him/her.

What will make students think? What will turn them on so that they want to think? Junior high students have a lot of things on their minds besides the things that the teacher is trying to make happen to them. What will bring the students attention to the classroom environment that the teacher would like to foster?

It should be a primary goal to prepare students to make intelligent, rational decisions. Children need to be prepared to:

*make decisions they will face in the future
*understand the role of science in their everyday lives
*recognize the importance of technology
*recognize the factors that have shaped their environment
*understand the nature and limitations of scientific knowledge
*evaluate in a non-prejudicial manner:
-written materials
-discussion
-media
-etc.
and as a result, develop confidence in communicating their own ideas

*appreciate that scientific knowledge can be used in a positive and negative manner by/on society
*realize that the earth's resources are not infinite
*realize that decision-making many times involves moral dilemmas.

The instructors, by taking a look at what instructors are trying to do with students, maybe will see themselves and their students in a more realistic light. They can decrease their percentage of failure -- failure to get and keep students interested in the forces that shape their lives - "Science" - the life course - the course that everyone uses, to some degree, throughout their visit on this earth. Instructors work at getting students to see science as a real-world concern.

How do instructors make this difference in a child's life? How do they know that we are making a difference? What are some indicators? Some of the ways include:

1. awareness-dealing with a problem from current news, local issues, or mutual interest;
2. interest-establish a position on a subject prior to actual encounter-give the participants a chance to share this opinion with others; (Information taken in is interpreted in terms of what is already known.)
3. examine alternatives, consequences, and impact;
4. organize discussion (small and large group) to share, rank, justify, clarify issues and consequences, and propose solutions; and
5. demonstrate commitment, take action/stand on an issue based on acquired data and be willing to communicate this.

How to teachers structure their teaching strategies to accommodate all of the above characteristics? Some ways are:

1. structure the classroom to manage instruction effectively: verbal, written, non-verbal, logistical;
2. organize for instruction: individual, small group, tutorial, didactic-conference;
3. develop responsive behaviors that create a classroom climate that is terminal or closed, open or extending. Create teacher/student behaviors that are accepting-passive-active or empathetic; and
4. include in the "bag of tricks"
   *directive strategies-help students to remember important facts, ideas, and skills
   *meditative strategies-help students create new solutions, insights, and fluency
   *collaborative strategies-help students learn to relate to each other and how to work cooperatively in groups.

"A teaching strategy, by definition, is a sequential arrangement of instructional activities that are employed over time and are intended to achieve a desired student learning outcome. Incorporated within a teaching strategy are specific teaching skills such as questioning, communicating directions, structuring, and responding to students' answers. Within a teaching strategy, the teacher also employs a repertoire of instructional techniques such as unique classroom

arrangements and grouping patterns, ways of causing interaction, and various approaches to the use of instructional materials."

Evaluation. In conjunction with the reading and writing program and the philosophy - "Think it + write it = know it," students do all of their work in journals. The journal is a place to take/keep notes, worksheets, assignments, and more importantly, to communicate with the instructor as to the level of understanding regarding a particular topic. Each day the student has responsibility for an entry and a summary which includes three required parts: 1) things I learned today, 2) things I didn't understand today, and 3) questions I have. The journals are collected, sometimes announced and sometimes unannounced, and evaluated by the instructor, usually on a weekly basis.

Journal quizzes are given periodically. For a journal quiz, the student uses the journal help-answer questions that are developed for 1) recall, 2) analysis, 3) comparison, 4) inference, and 5) evaluation (judgment) of a particular concept(s).

Traditional tests and quizzes using a variety of formats, by necessity due to each new situation, are developed as the course progresses. Since the direction a particular group may take is somewhat undefined, what exactly is to be studied, how it will be studied, and the final result of the study on unknown, it becomes necessary to base evaluation on class/group outcomes.

Evaluation of creativity, process, attitudes in science is being monitored throughout grades 7-12. The tests, which were developed at the University of Iowa as a result of the Chautuaqua program, attempt to measure student growth as they progress through science at Glidden-Ralston.

The creativity test, which poses a question, and solicits student response, is also used as a pre-post test for units of study. Student responses are evaluated as either pertinent to the question or unique (creative). The test item serves to show an increase in student understanding of a particular topic, as well as attempting to measure the level of critical thinking. Limited test results indicate that 68 percent of all students tested have shown growth in the creativity area. Use of the test for growth in content areas has also shown to be effective. As a result of testing in the creativity domain, this year's semester test format was changed from a traditional objective test to one utilizing the creativity (response and classification) scheme.

Process testing monitors student progress in deductive and inductive thinking skills processes, as well as the understanding of connections to science to unique situations. At this time, results of process testing indicate that 66 percent of the students showed growth in these skills during the one year tested.

With attitude testing, we are trying to determine the status of the students' interest/outlook in science as they enter and move through the subject areas. We hope to see/maintain positive changes in student attitudes toward science through yearly testing. In addition, pre-post attitude tests which are developed by the teacher are used for a particular unit of study. Results of attitude testing indicates that the student have a positive attitude toward science upon

entering the seventh grade and that this attitude is being maintained through graduation to high school.

When comparing student scores on Iowa Tests of Basic Skills (ITBS) and Iowa Test of Education Development (ITED), it has been noted that performance is equal to or improved over past results.

Maintenance Needs. Two staff instructors make up the science staff for the middle school at Glidden-Ralston. The two staff members work together to help and advise the development of curriculum structure and content.

Due to attendance and involvement with the University of Iowa Chautauqua Program, both instructors have established a network of support staff throughout the State of Iowa and regionally. When there is a need for help/advice regarding a particular unit of study, an instructor can locate another instructor who is doing work in a similar area. The idea of networking, as well as involvement in follow-up meetings, has been one of the remarkable outcomes of the Chautauquas.

In addition to relying on peers for advice in planning and implementing curriculum, the staff at the Chautauqua Center, located at the University of Iowa Science Education Center, is always available for help.

In general, there have been very positive responses to the STS program; and, because of this, a strong network of teachers has evolved. Because of the interaction that frequently occurs at meetings, over the phone, and through written communication, teachers are becoming more active in their classrooms and more willing to attempt the unfamiliar.

Community Resources. Glidden is a relatively small rural community. The resources available, however, have been put to use effectively. Since most of the instructors and supervising personnel at the businesses are on a first name basis, the connection between the science classroom and the community has been made. For example, the egg processing plant accommodates a field trip/tour on short notice, and the city utilities open the doors for a visit to the water treatment facility.

Resources in the community of Carroll, which is located seven miles west of Glidden, are also very beneficial and cooperative. For example, the connections that we attempt to make regarding the study of groundwater are strengthened by visits from the Carroll County Sanitarian, the Carroll County Heath Specialist, the Carroll County Naturalist, and many others.

By using the "experts" to initiate, communicate and reinforce what is happening in the "real world," the study of science is more interesting and relevant to the students and the instructors.

Each teacher operates on a budget which is established for the department at the beginning of the school year. During the 1988-89 year for example, the two instructors for grades 7-12 will be operating on a $1,200 figure. The administration established the budget and the curriculum chairman is responsible for allocating the money.

The administration is very supportive of the teaching staff and encourages innovative and exploratory education. A dynamic approach to education is emphasized by the administration. Updating curriculum, monitoring student achievement, and meeting the guidelines established by national and state agencies are given high priority. Attendance by teachers at workshops to keep in tune with current trends in education is strongly encouraged. Teachers are allowed to investigate and implement their ideas into their classroom. The staff of the school system, for the most part, is a very experienced staff and works together very well. Frequent staff/curriculum meetings allow teachers and administrators to share what is going on in the classroom.

Written Materials. The earth science program has six major units of instruction. All units are designed to meet minimum requirements at Glidden-Ralston and to correlate to the Iowa Department of Education standards.

Evaluation instruments are developed as the unit of instruction proceeds. Due to the diverse nature of the course it is necessary to structure each evaluation instrument based on the outcome(s) of the study.

Various articles about our program have appeared in *Iowa Natural Heritage*, Summer, 1987, "Involve Me and I will Understand"; *Chautauqua Notes*, 1987-1989; *Glidden Graphic*, September, 1987, "New Science Program Arouses Student Interest"; and *Carroll Today*, May, 1988, "Outdoor Learning Experiences".